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PROCESSOR: CHW

NUMERICAL SOLUTIONS OF

SPHERICAL BLAST WAVES

H. L. Brode

P-571 - AEC (SUPPLEMENT)

18 July 1955

The RAND Corporation
1700 MAIN ST. • SANTA MONICA • CALIFORNIA

The figures in the article entitled "Numerical Solutions of Spherical Blast Waves" served as illustrations of the general nature of the solutions rather than as accurate graphs or working curves. Since there has been some demand for more usable numerical results, this supplement, consisting of more readable figures and some additional curves, has been assembled.

The added figures (Figs. 13, 14, 15, 16, 17,) are of temperature versus radius at the indicated times. They represent temperature profiles for the point source solution for an ideal gas ($\gamma = 1.4$). Note that the temperature is monotonically decreasing with increasing radius for all times before a negative phase develops. Also note that the temperature at a fixed radius may increase appreciably above the shock temperature before eventually dropping off. The profiles at later times illustrate the rather sharply defined high temperature region near the center that remains long after the shock is gone. Because of the emphasis in this problem on shock detail, the behavior of the various hydrodynamic quantities near the origin is least well defined. That region is also the region where the ideal gas assumption is least valid for air; consequently results in this region should be used with caution.

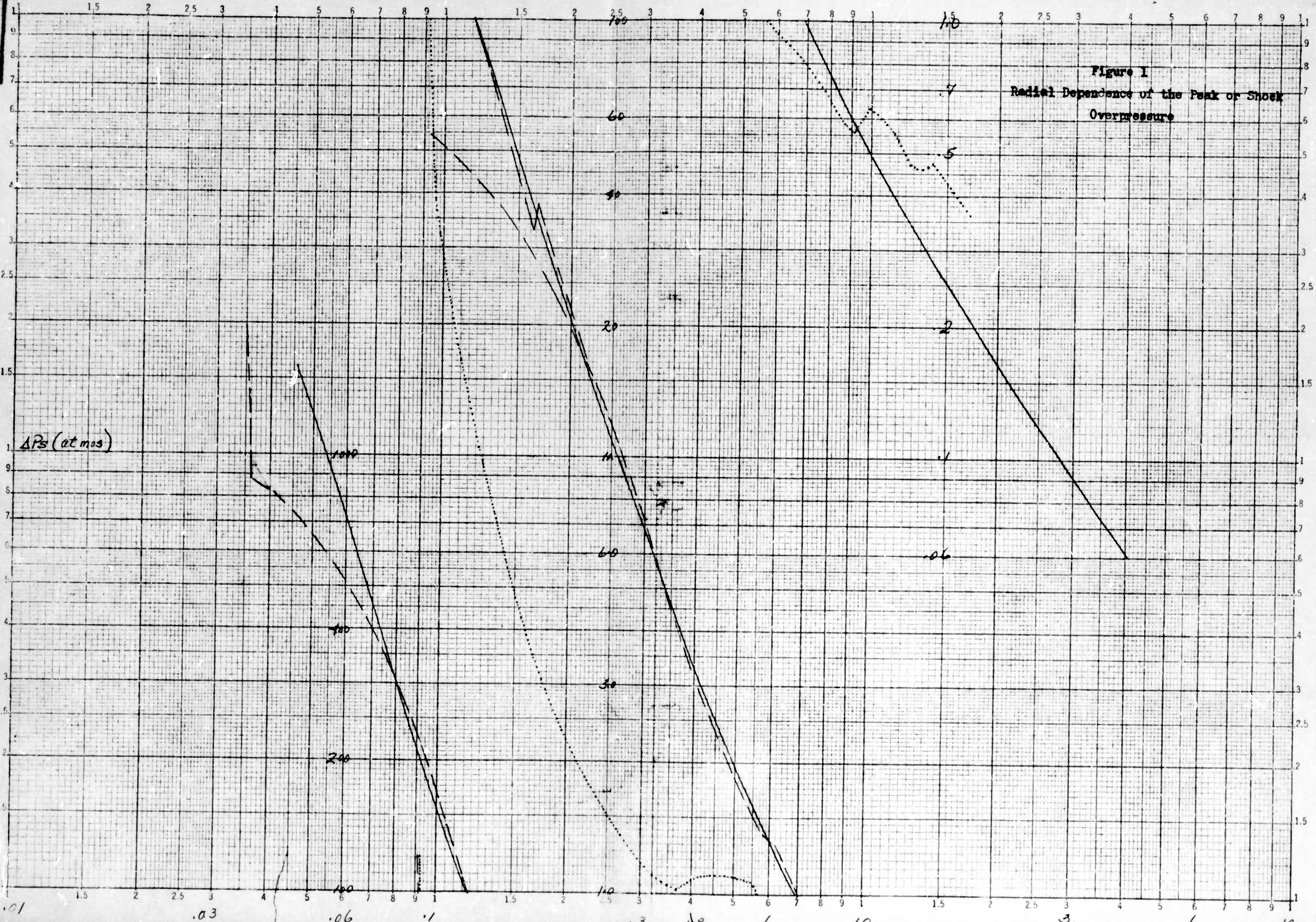


Figure I
Radial Dependence of the Peak or Shock
Overpressure

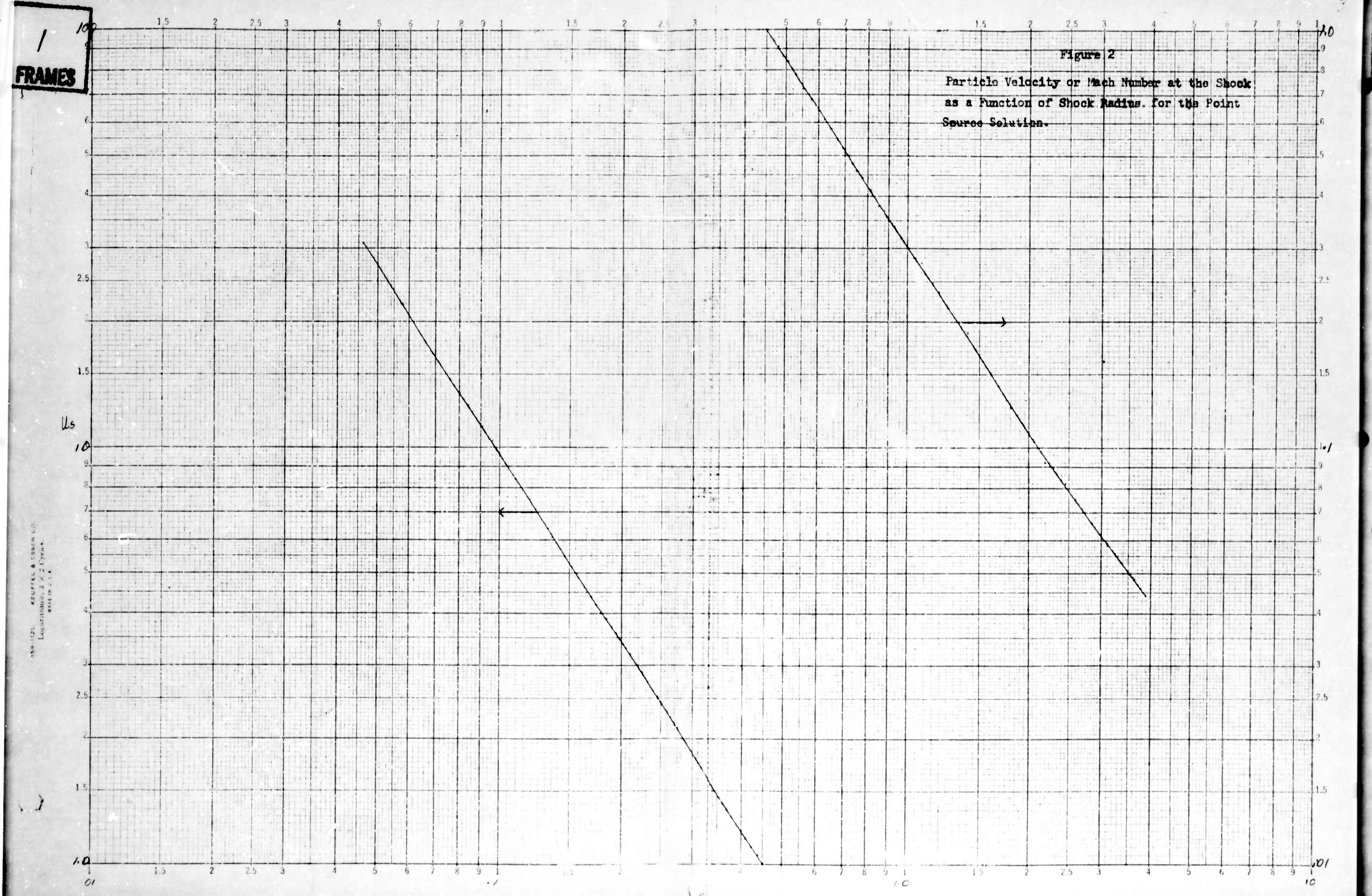


Figure 2

Particle Velocity or Mach Number at the Shock as a Function of Shock Radius. for the Point Source Solution.

1
FRAMES

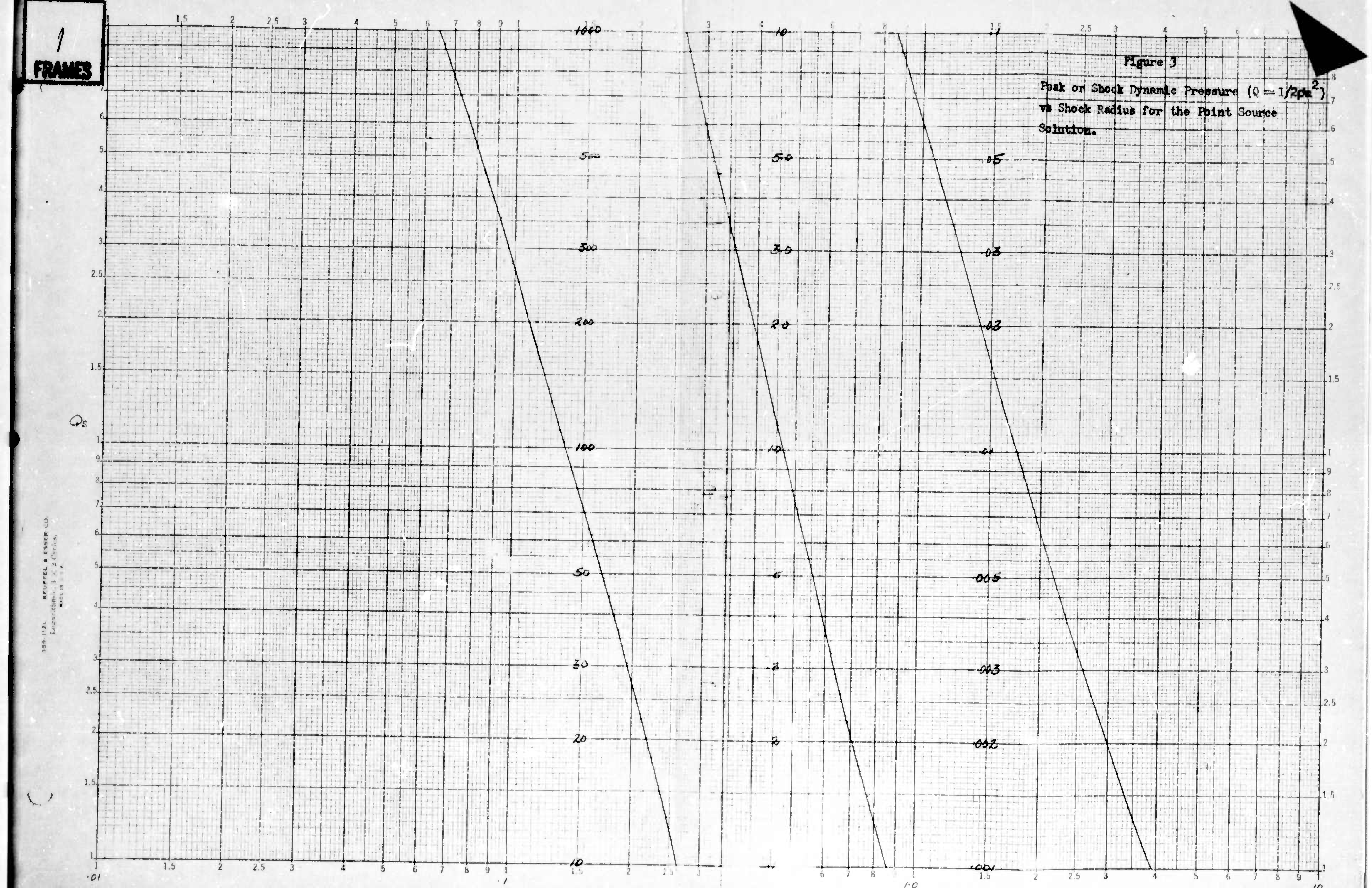
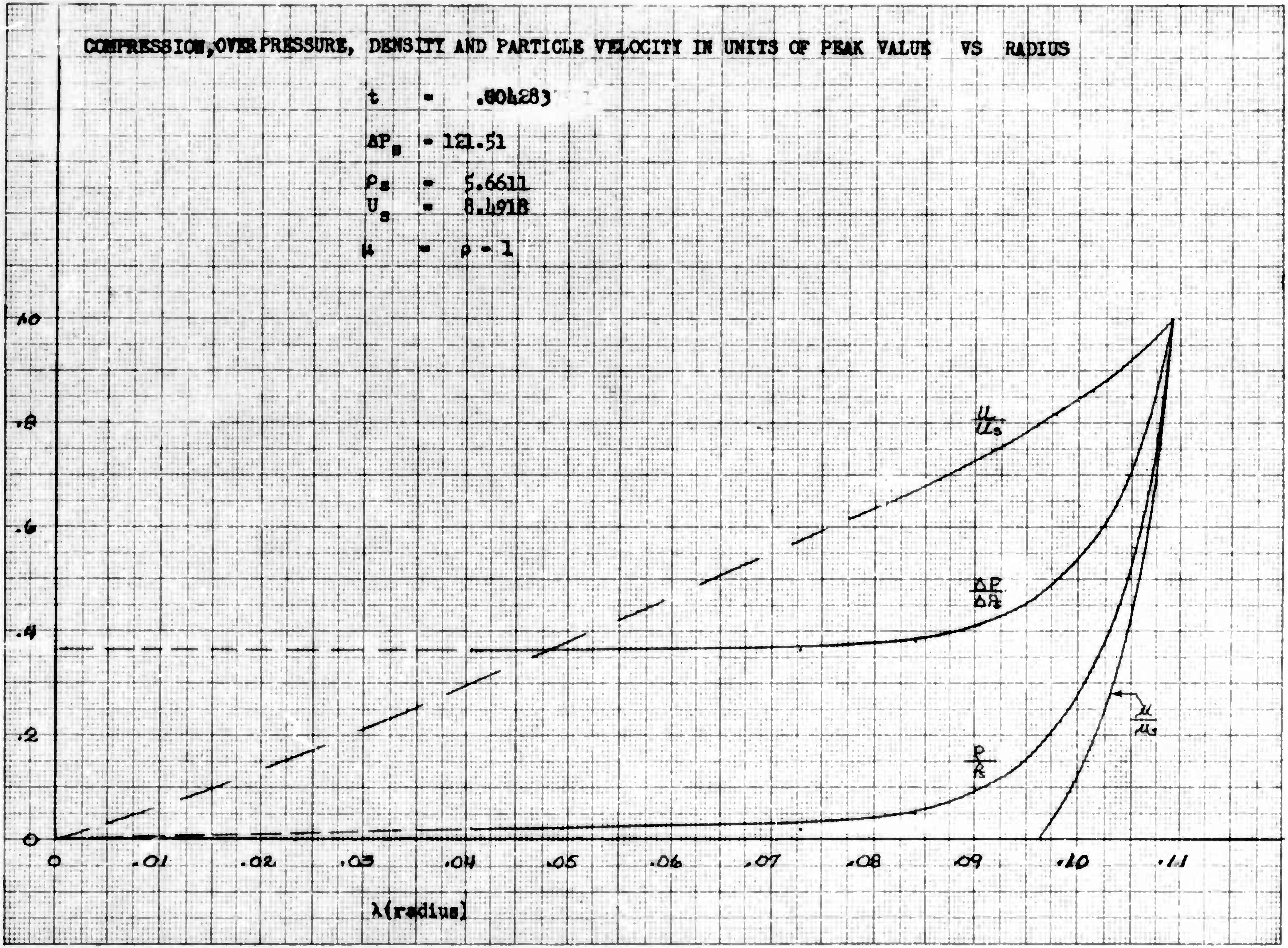
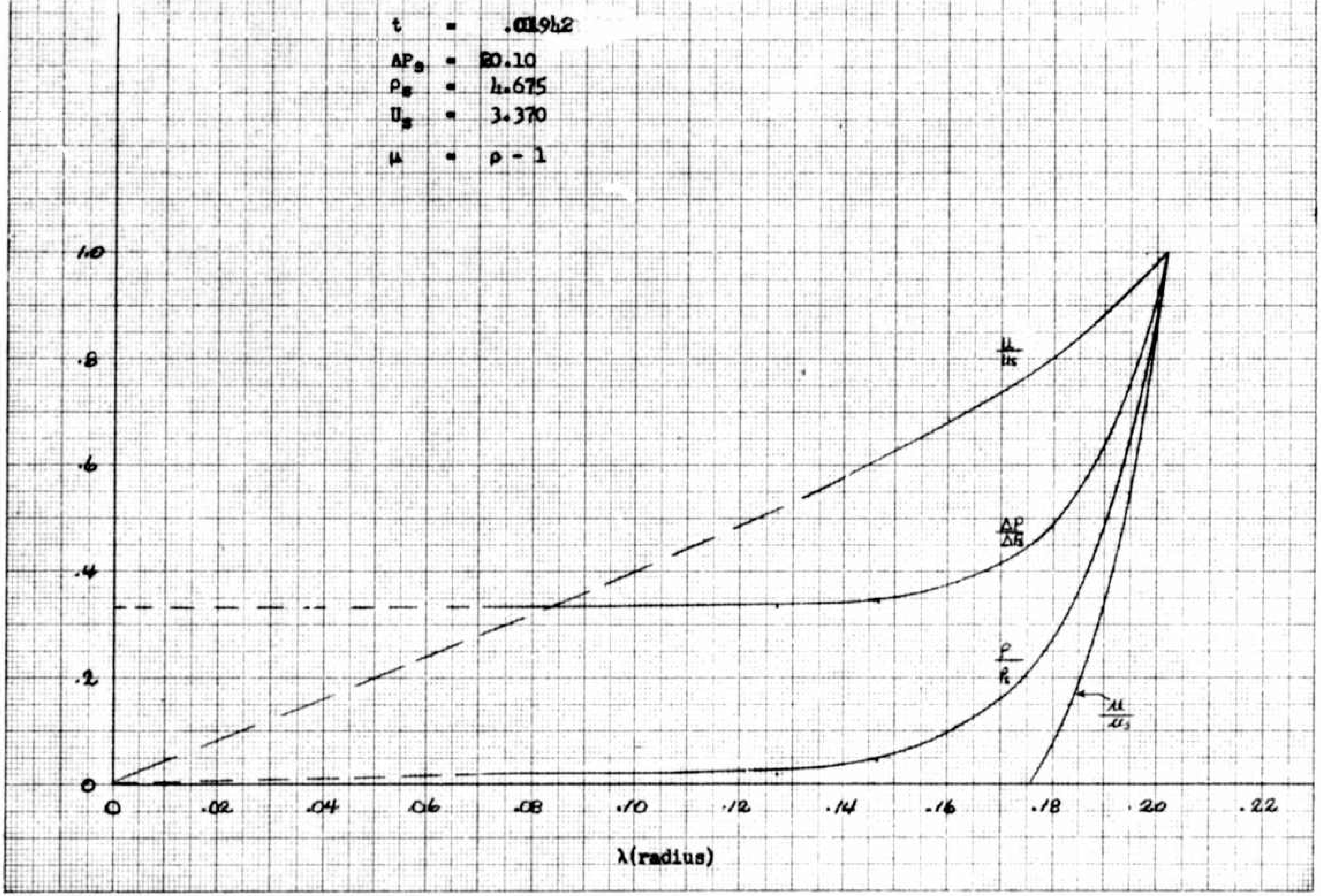


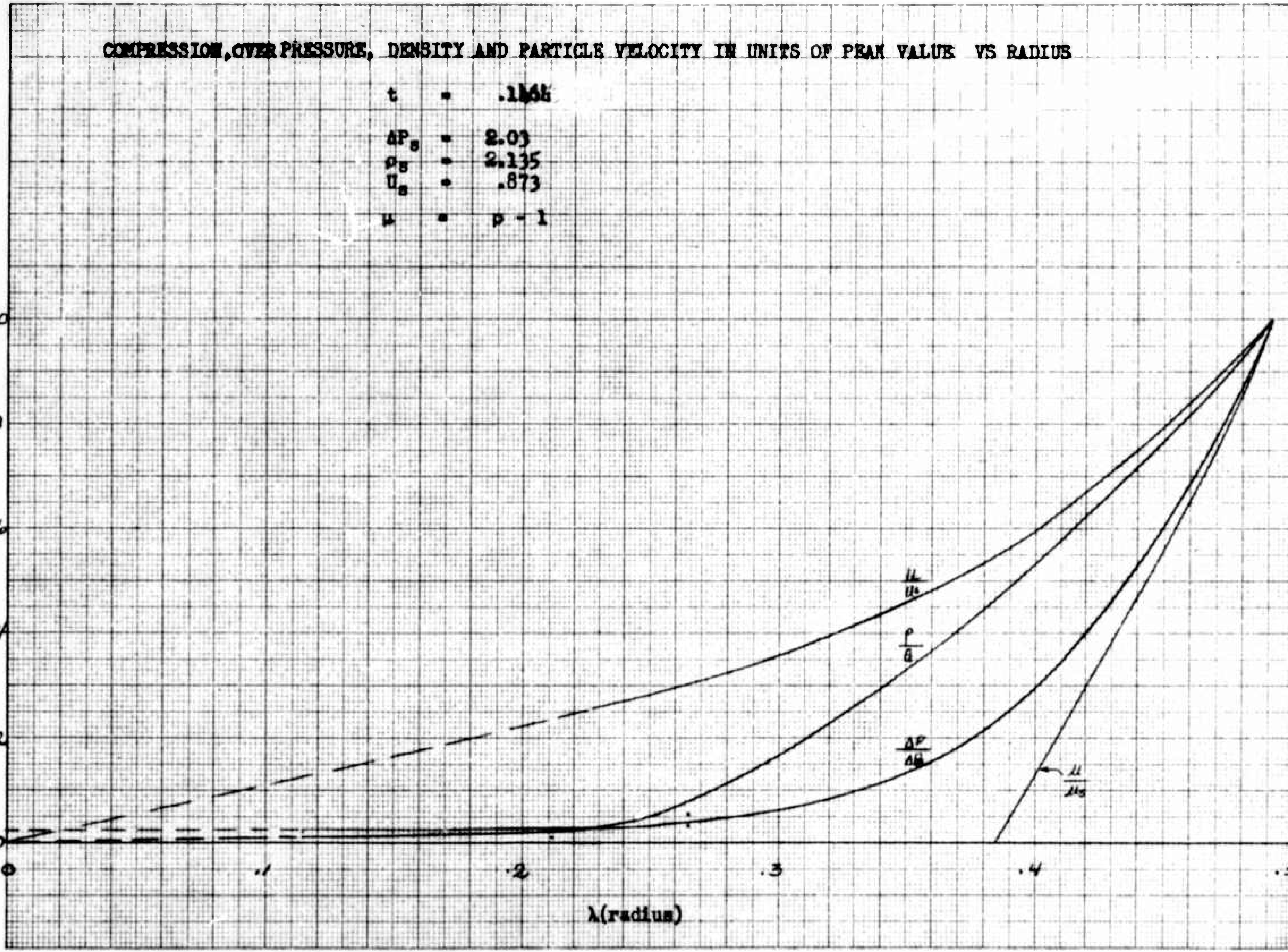
Figure 3

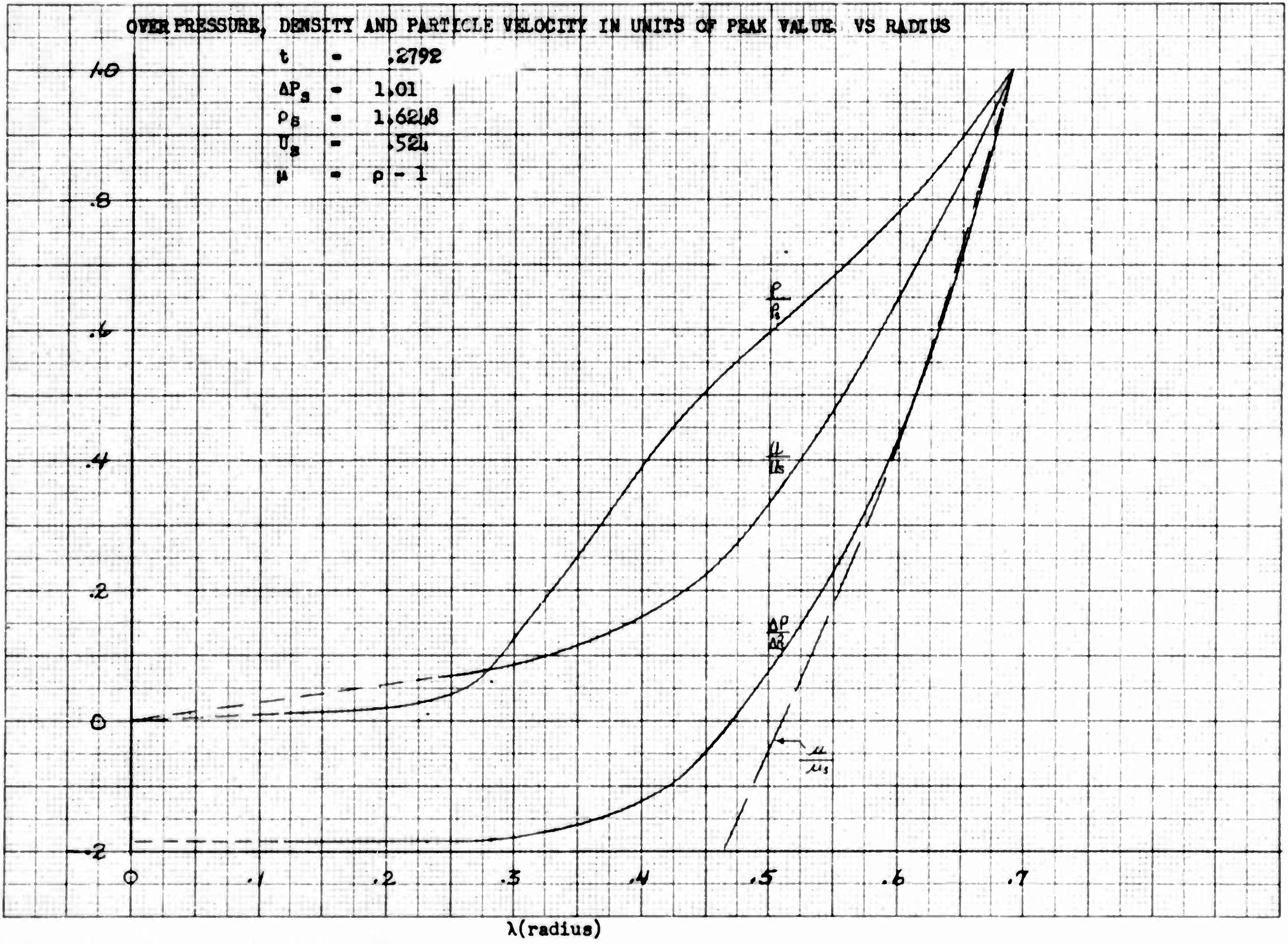
Peak or Shock Dynamic Pressure ($Q = 1/2\rho u^2$) vs Shock Radius for the Point Source Solution.

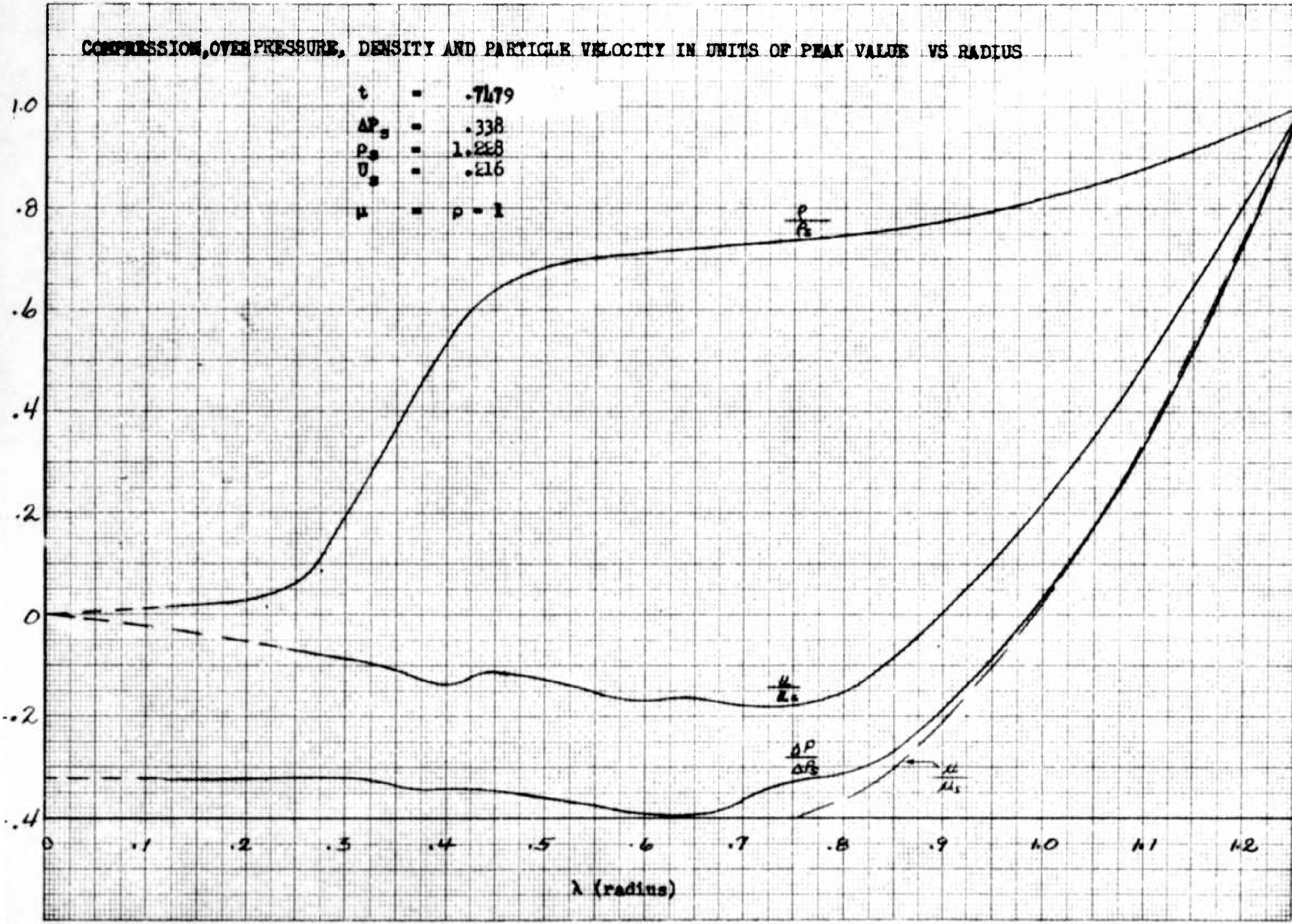

COMPRESSION, OVERPRESSURE, DENSITY AND PARTICLE VELOCITY IN UNITS OF PEAK VALUE VS RADIUS
t = .004283
ΔP_s = 121.51
ρ_s = 5.6611
U_s = 8.4918
μ = ρ - 1
u/u_s
ΔP/ΔP_s
ρ/ρ_s
μ/μ_s
1.0
.8
.6
.4
.2
0
0
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
.11
λ(radius)

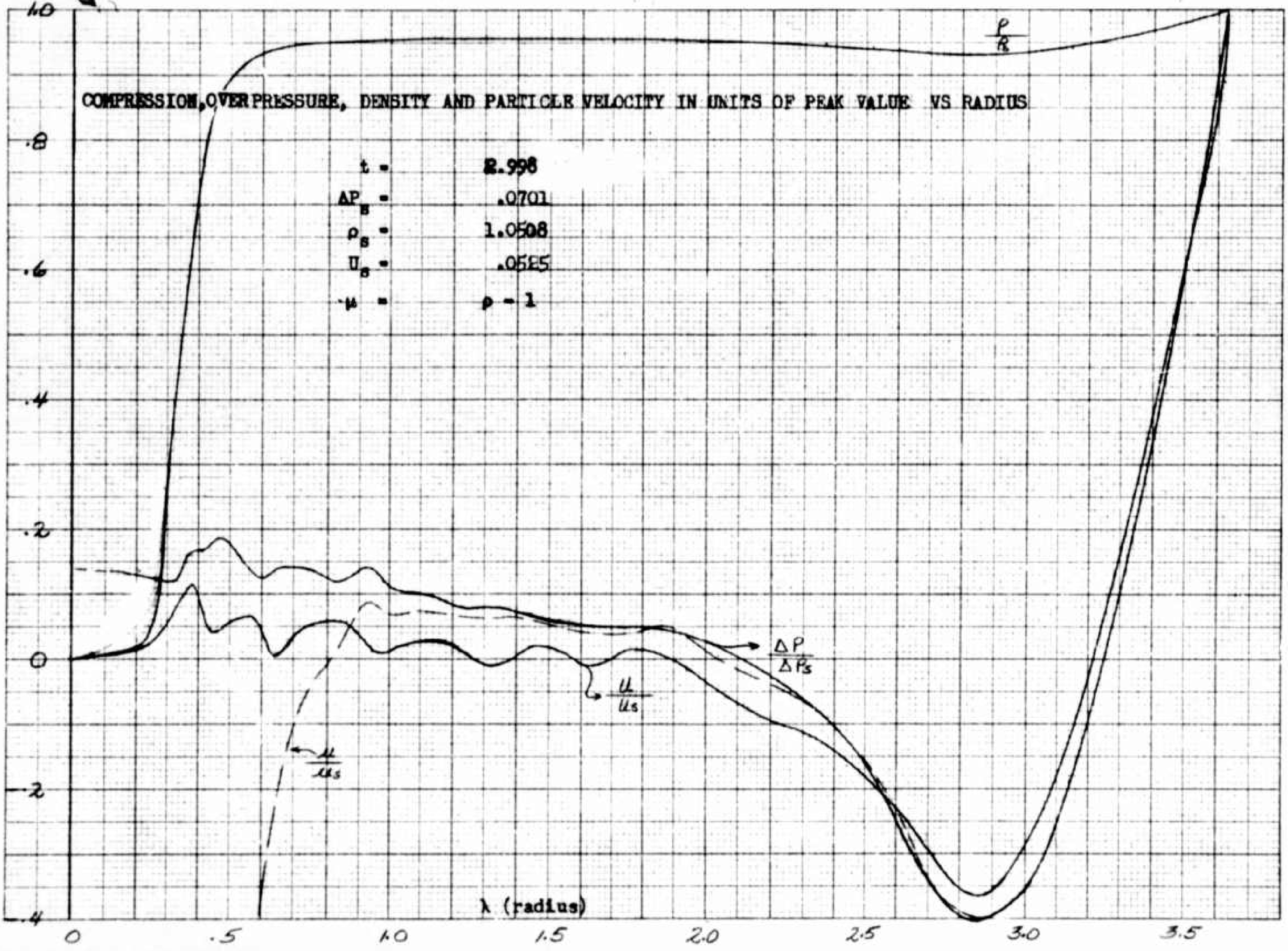
COMPRESSION, OVERPRESSURE, DENSITY AND PARTICLE VELOCITY IN UNITS OF PEAK VALUE VS RADIUS




COMPRESSION, OVERPRESSURE, DENSITY AND PARTICLE VELOCITY IN UNITS OF PEAK VALUE VS RADIUS
t = .1
ΔP_s = 2.03
ρ_s = 2.135
U_s = .873
μ = ρ - 1
1.0
.8
.6
.4
.2
0
.1
.2
.3
.4
.5
λ(radius)


OVER PRESSURE, DENSITY AND PARTICLE VELOCITY IN UNITS OF PEAK VALUE VS RADIUS
t = .2792
ΔP_s = 1.01
ρ_s = 1.6248
U_s = .524
μ = ρ - 1
1.0
.8
.6
.4
.2
0
-.2
0
.1
.2
.3
.4
.5
.6
.7
ρ/ρ_s
u/u_s
ΔP/ΔP_s
μ/μ_s
λ(radius)


COMPRESSION, OVERPRESSURE, DENSITY AND PARTICLE VELOCITY IN UNITS OF PEAK VALUE VS RADIUS
t = .7479
ΔP_s = .338
ρ_s = 1.228
U_s = .216
μ = ρ - 1
ρ/ρ_s
u/u_s
ΔP/ΔP_s
μ/μ_s
1.0
.8
.6
.4
.2
0
-.2
-.4
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
λ (radius)


COMPRESSION, OVERPRESSURE, DENSITY AND PARTICLE VELOCITY IN UNITS OF PEAK VALUE VS RADIUS
t = 2.998
ΔP_s = .0701
ρ_s = 1.0508
U_s = .0525
μ = ρ - 1
ρ/ρ_s
ΔP/ΔP_s
u/u_s
μ/μ_s
λ (radius)
1.0
.8
.6
.4
.2
0
-.2
-.4
0
.5
1.0
1.5
2.0
2.5
3.0
3.5

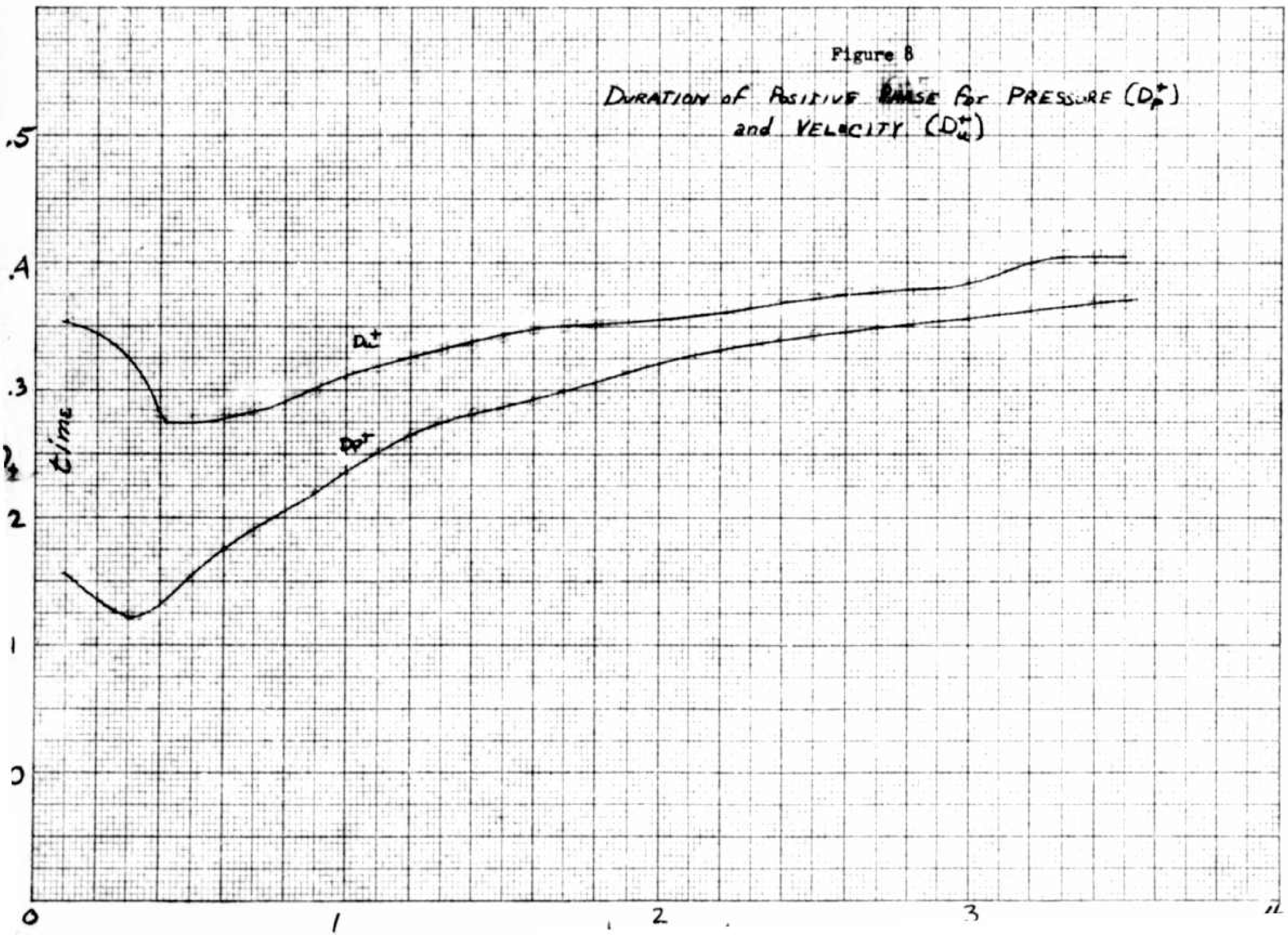
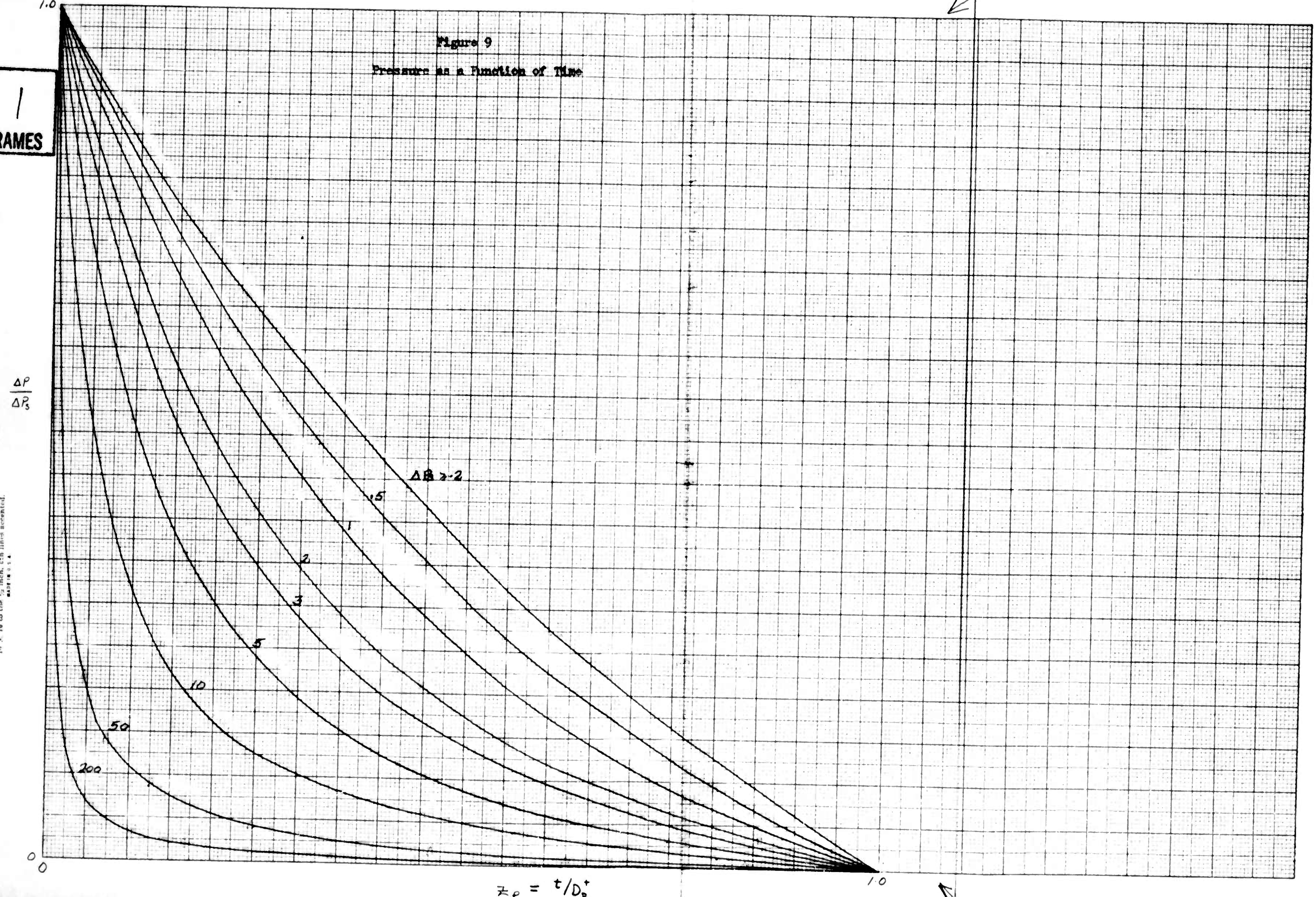


Figure 8

DURATION of POSITIVE PHASE for PRESSURE (D_p^+) and VELOCITY (D_u^+)

Figure 9

Pressure as a Function of Time



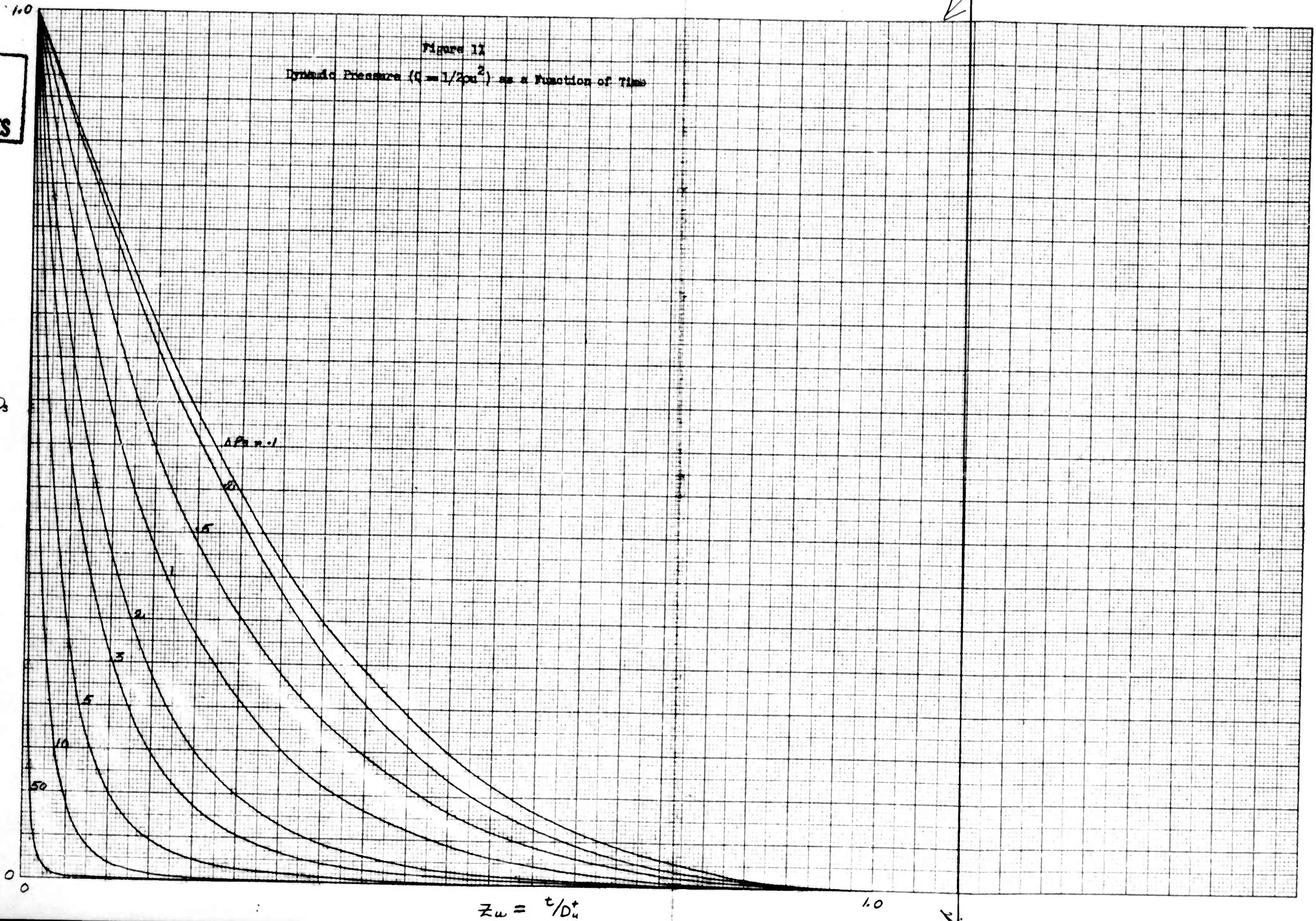
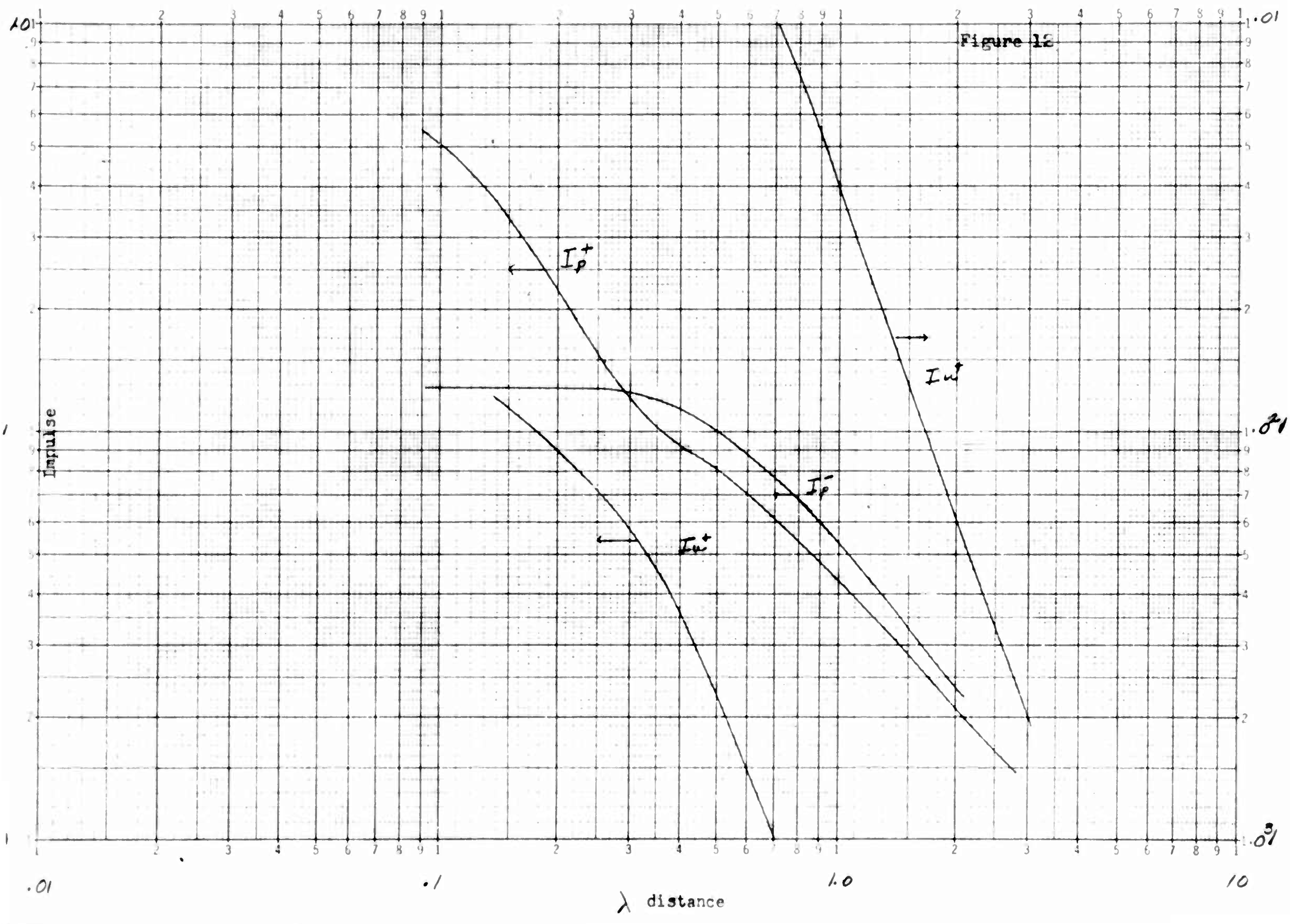


Figure 11

Dynamic Pressure ($Q = 1/2\rho u^2$) as a Function of Time

Figure 12



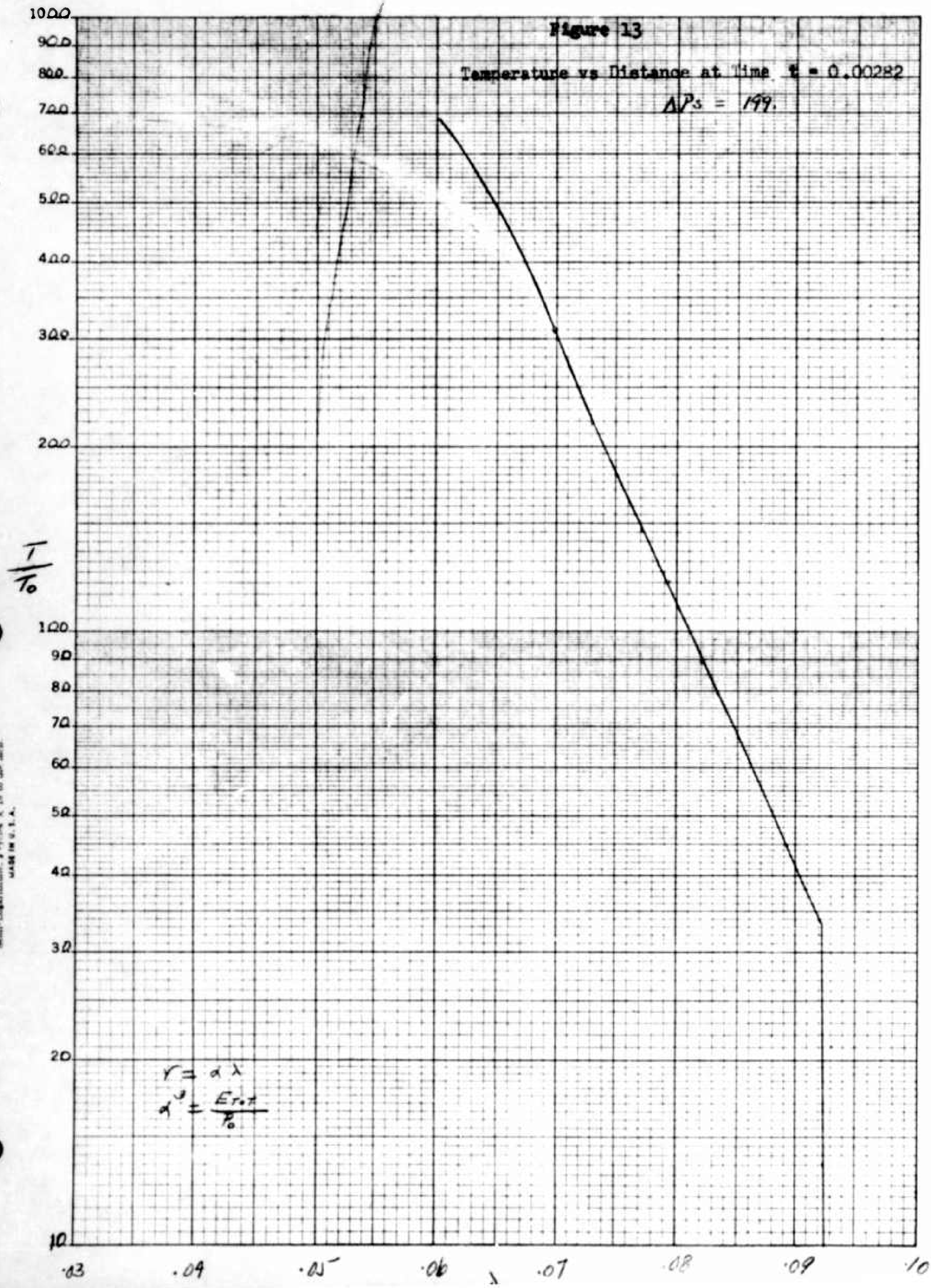


Figure 13
Temperature vs Distance at Time t = 0.00282
ΔP_s = 199.
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
$\frac{T}{T_0}$
$r = \alpha \lambda$
$\alpha^3 = \frac{E r_0 t}{P_0}$
.03
.04
.05
.06
.07
.08
.09
.10
λ

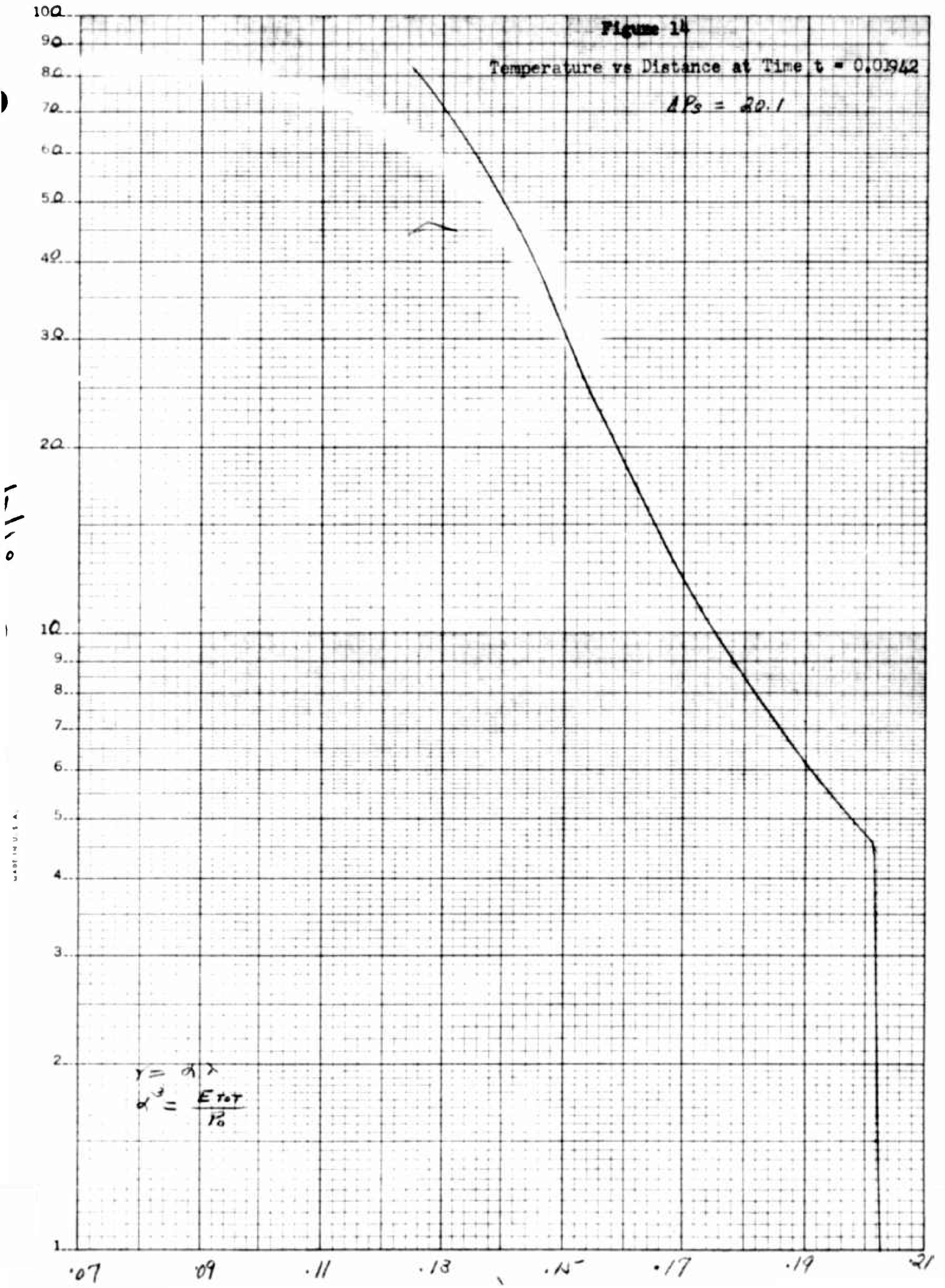


Figure 14
Temperature vs Distance at Time t = 0.01942
ΔPs = 20.1
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
T/T0
r = αλ
α³ = E_TOT / P0
.07
.09
.11
.13
.15
.17
.19
.21

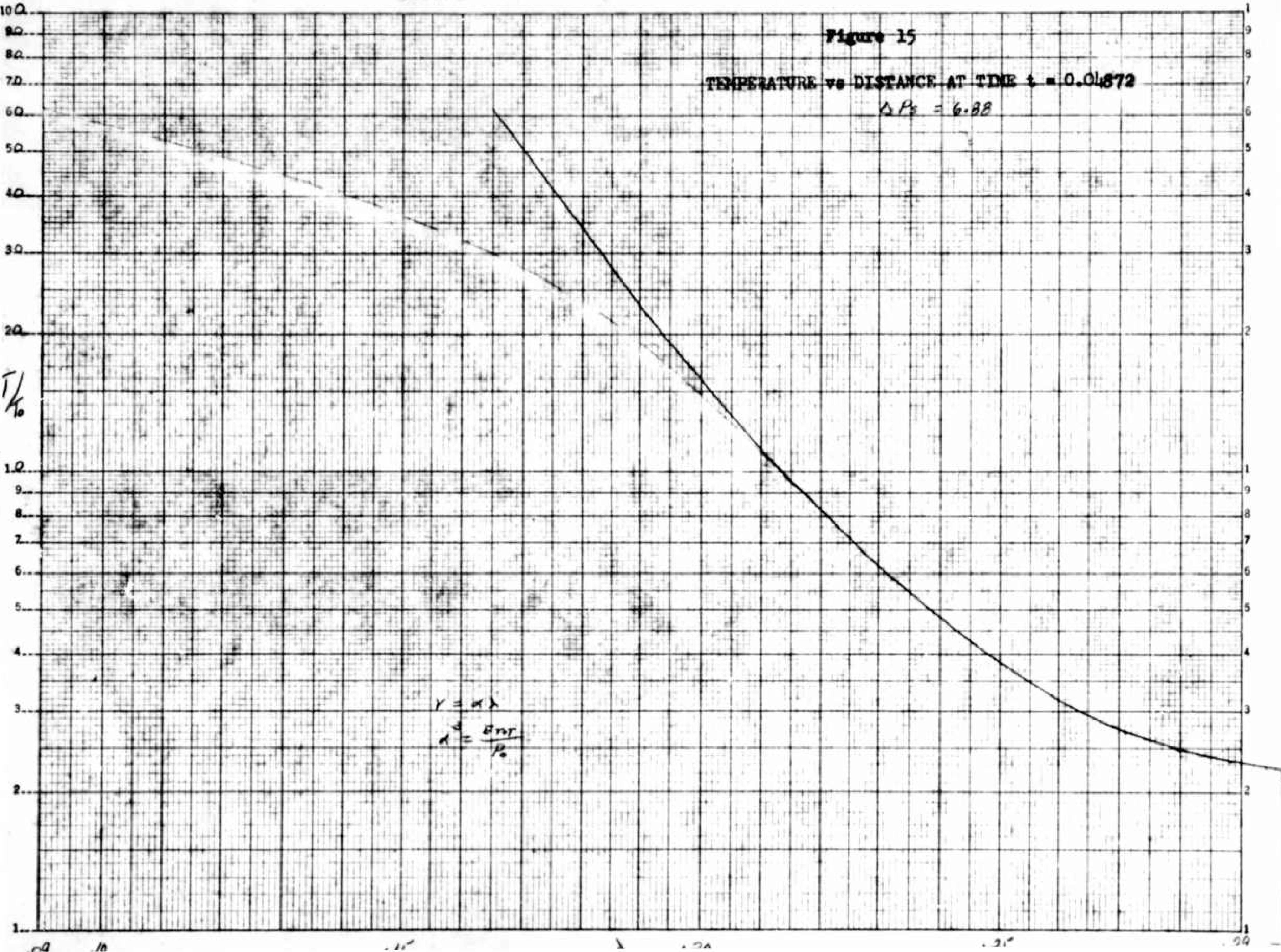


Figure 15
TEMPERATURE vs DISTANCE AT TIME t = 0.04872
$\Delta P_s = 6.88$
T/T_0
$r = \alpha\lambda$
$\alpha^2 = \frac{8nT}{P_0}$
λ

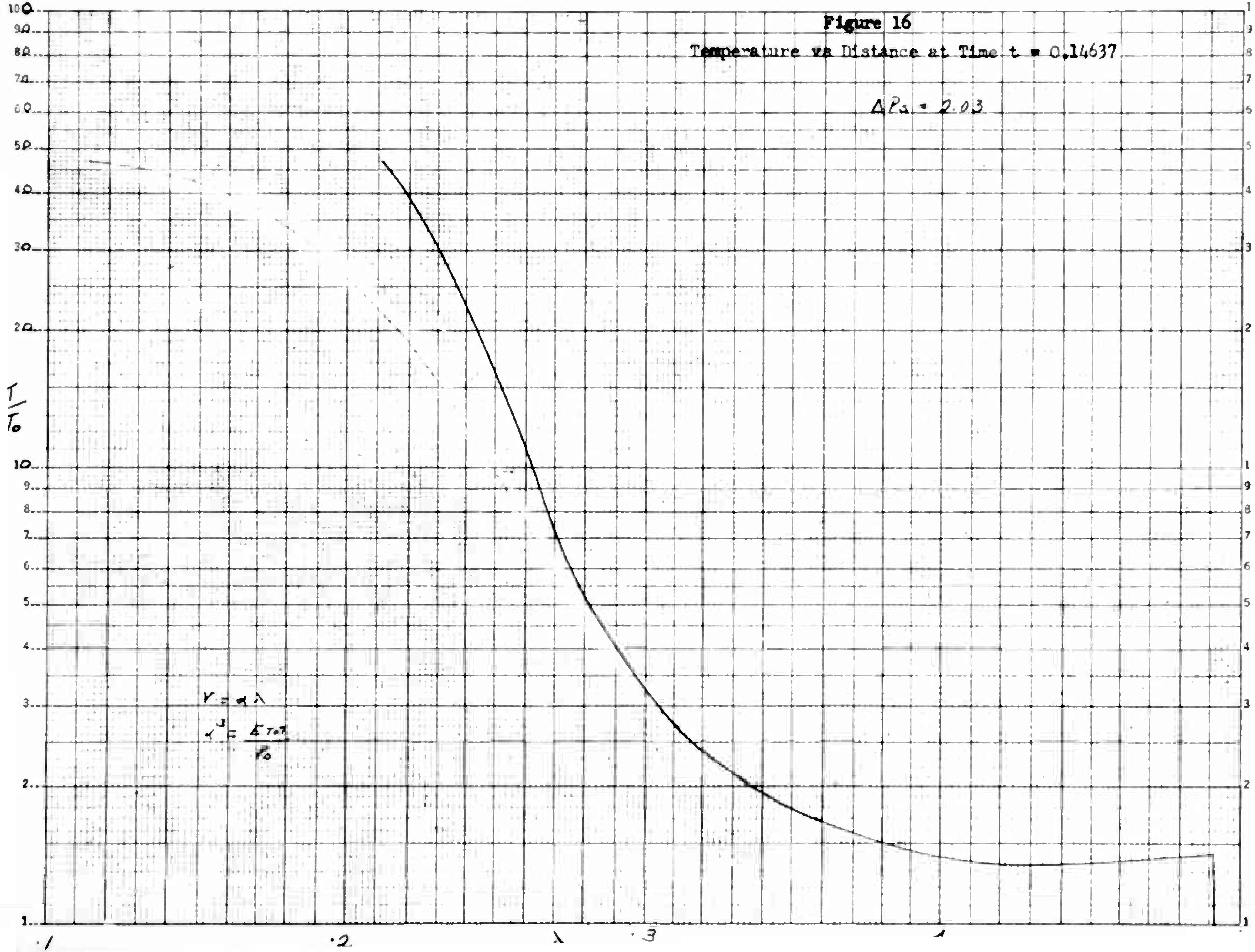


Figure 16
Temperature vs Distance at Time t = 0.14637
$\Delta P_s = 2.03$
T/T_0
$r = \alpha\lambda$
λ

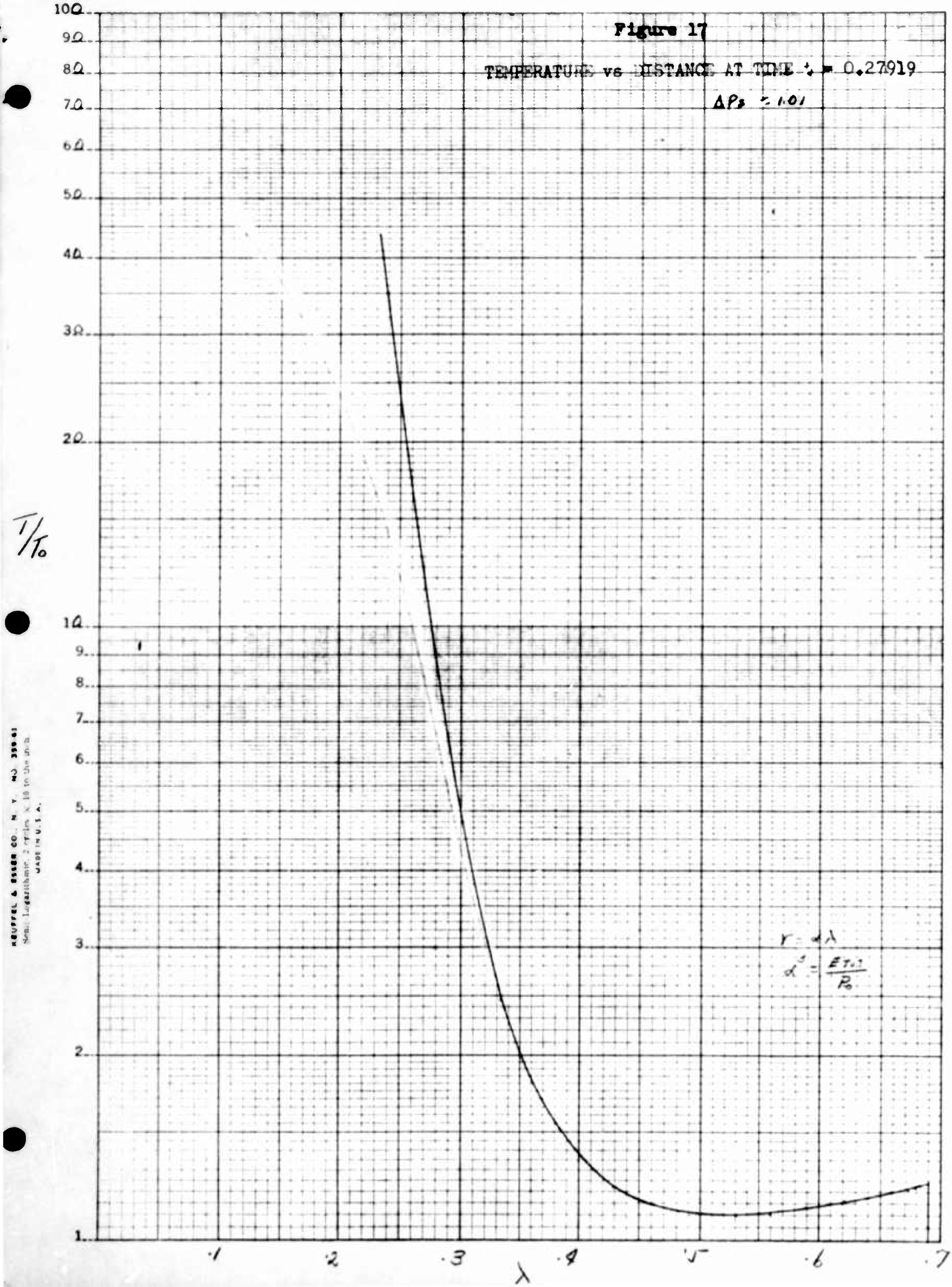


Figure 17
TEMPERATURE vs DISTANCE AT TIME = 0.27919
ΔPs = 1.01
T/T₀
λ
r = αλ
$\alpha^3 = \frac{E}{P_0}$